Introduction to Graphics

Final Assignment: Parametric Surfaces

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1 Parametric surfaces Implementation

I have had very little success getting this to work, as the next few pages will show.

1.1 Creating Patches

To parse the patches from the data files into BeizerPatch data i used the ReadBezierPatches and saved it into a vector of BezierPatch.

```
    std::vector<BezierPatch> patches;
    ReadBezierPatches("data/teapot.data", patches);
```

I then iterate over the patches, initializing each patches buffers.

```
for (int i = 0; i < patches.size(); i++){
    GLPatch patch;
    patch.initializeBuffers(triangleShaderProgram, patches.at(i));
    buffers.push_back(patch);
```

After the calculations of the perspective and shading each patch is drawn by calling the draw() function, and then swapping to the new drawn on buffer.

```
for (int i = 0; i < buffers.size(); i++)[
    buffers.at(i).draw();
    }
glutSwapBuffers();
```

1.2 BezierPatch formating

I chose to save the patch values in a list of floats, that is created much like i created with an algorithm much like the subdivision algorithm in the previous assignment. It splits the patch into subpatches until it does not pass the flatnesstest, then it adds every point into the float list, using a helper algorithm i created.

1.3 Results

I created a few tests to find that the lists in each patch is filling out, but i am unable to find the points in my world. This made me move my PRP closer to the points where the teapot should be located and i discovered that one of the patches was being drawn, as shown on figure 1.
I also discovered the patch was only being drawn on some runs of the program. This makes me belive i am doing something very wrong as that should not be right. My first though is i missunderstod the way the patches are being drawn, so i should not create a new instance of the GLPatch class everytime i wish to create a new patch. If this is the case the reason for the shown patch are only sometimes drawn, could be the program picking one of the initialized GLPatches

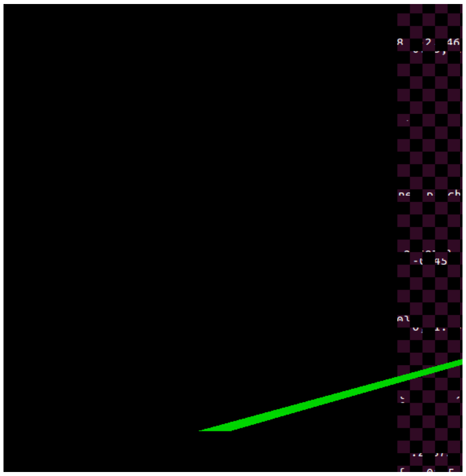


Figure 1: A teapot patch

and drawing that on the buffer, repeating this with new buffers and new patches without saving the old.
I belive this to be a my mistake as i know it is possible for the code to draw one patch, as i used the same code to draw the triangles shown below on figure 3.

1.4 Late thoughts

It is currently a little to late to make as widespreading changes as this demands. But i belive i know where i am going wrong, unfortuantly i ran out of time before i could get a working version. I should only be creating one GLPatch and save all the patches values inside of this one patch, instead of the current implementation where i have a buffer for each patch. This would allow the program to draw everything on the buffer before swapping it into view. Implementing this would mean removing all the BezierPatches code from the main only leaving patch as a global variable in the file, this is left so i can do an init and a draw call on it when needed. I would still need to calculate the Phong constants and perspective matrix in the main.cpp file.

```
static void intializeShadersAndGLObjects() {
    ...
    patch.initializeBuffers(triangleShaderProgram);}

static void renderSceneCB() {
    ...
    patch.draw();}
```

In the GLPatch class i would need to revert the initilizeBuffers back to where it only takes a ShaderProgram as a parameter and call the teapot data from here. I would need to save every patch in a list of floats and bind them to the buffer.

```
std::vector<BezierPatch> patchesv;

ReadBezierPatches("data/teapot.data", patchesv);

for (int i = 0; i < patchesv.size(); i++)
   paramSurfaces(patchesv[i], patch);

   GLuint m_Patch;
   m_Patches[i] = m_Patch;
   glGenBuffers(1, &m_Patch);
   glBindBuffer(GL_ARRAY_BUFFER, m_Patch);
   glBufferData(GL_ARRAY_BUFFER, sizeof(patch), patch, GL_STATIC_DRAW);
}
```

Then when the draw function is called i draw from every patch with a new forloop. I did not have time to implement this, but i do belive this would have given me at least the teapot drawn.

2 Previous work

During my work on the final assignemnt, i used a lot of time getting my Phong shader working, with this i would like to correct the mistakes from my previous report and write my latest knowledge and work on the subject. I write this in hopes of it redeeming some of the missing code from my previous assignments.

2.1 Subdivision

In the previous assignment i had a few problems with ordering of the points, this was fixed so the subdivision curves now looks as seen on figure 2.

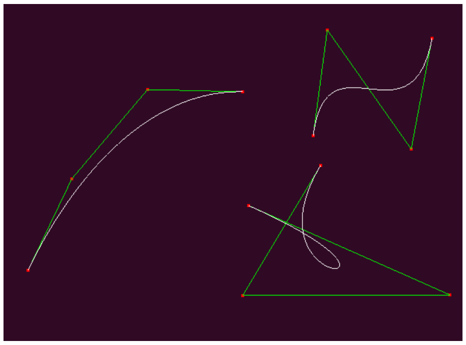


Figure 2: Subdivision curves

Previously i forgot to switch the values on the right side, as $R[4]$ is the last point on the curve, and not the middle one. So the new right side of the reccursion looks like so:

```
drawBezierSubdivision(Right[3], Right[2], Right[1], Right[0], ceil(n/2)-1);
```

2.2 Phong Shading

I am, as previously, using the gl function *glUniform4f* to save variables from the main code into the `Fragment Shader`. This enables me to avoid a some of the very expensive `Fragment Shader` calculations by moving it out of the shader functions. This is however only possible on values that stays constant throughout the fragments, so calculations still has to be done on V, L and R, as these vectors are dependent on the position of the current vertex and the current model matrix.
These values are pulled out of the `Vertex Shader` and into the `Fragment Shader` using the *varying* keyword, that allows variables to be passed between shaders.

```
static const std::string sVertexShader = "
        #version 110

        attribute vec3 aPosition;

        uniform mat4 uModelMatrix;
        uniform mat4 uPerspectiveMatrix;

        varying vec4 vPos;
        varying mat4 vMat;

        void main() {
            vPos = vec4(aPosition.xyz, 1.0);
            vMat = uModelMatrix;
            gl_Position = uPerspectiveMatrix * uModelMatrix
                                             * vec4(aPosition.xyz, 1.0);
        }
";

static const std::string sFragmentShader = "
        #version 110

        // from code
        uniform vec4 uAmb, uDif, uSpe, uNormal, uLightPos, uViewPos;
        uniform int un;

        // from vertexShader
        varying vec4 vPos;
        varying mat4 vMat;

        void main()        {
            vec4 V = normalize(uViewPos * vMat - vPos);
            vec4 L = normalize(uLightPos * vMat - vPos);
            vec4 R = reflect(-L, uNormal);
            gl_FragColor = uAmb +
                           uDif * dot(L, uNormal) +
                           uSpe * pow(dot(R, V), un);
        }
";
```

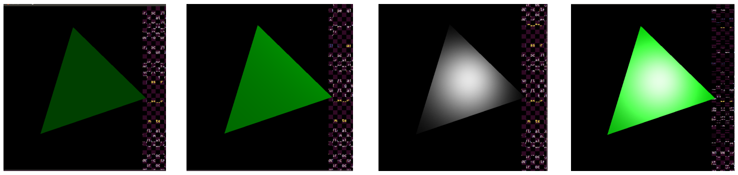
The Phong calculations of all the constants are done in a function called before the patches are drawnn. The only variable that is calculated on each iteration of the patches is the Normal.

```
Phong(Ia, Ip, Lpos, prp, vrp, Ka, Oa, Kd, Od, Ks, Os, Fatt, n);

for (int i = 0; i < buffers.size(); i++)
{
    glm::vec3 Nor = normals.at(i);
    glm::vec3 N = glm::normalize(glm::vec3(Nor[0],Nor[1],Nor[2]));

    gluniform4f(glgetuniformlocation(triangleshaderprogram.getprogram(),
                "uNormal"), n[0], n[1], n[2], 1.0);
    buffers.at(i).draw();
}
```

before this code all light variables are declared. the normals are saved in the normals variable, when the buffers are initialized. the shading can be seen on figures 3.



Ambient

Diffusal

Specular

All

Figure 3: Phong Shading